# TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. XXI. No. 21. DECEMBER, 1944. PRICE 6d.

CONTENTS.

| | PAGE |
|---|---|
| Fungus and Bacterial Diseases of Insects as Factors in Biological Control ... ... | 217 |
| The Aloes Industry in Mauritius ... ... | 218 |
| Co-operative Credit Societies in the South Caribbean Area ... ... ... | 219 |
| Ley Farming ... ... ... ... | 227 |
| Hedge Plants in Northern Nigeria ... ... | 228 |
| Organic Phosphorus in Soils ... ... | 230 |
| Response of Tea to Nitrogen ... ... | 231 |
| Chemical Notes ... ... ... ... | 232 |

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 0365

*TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and Subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, Grand Buildings, Trafalgar Square, London, W.C. 2, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.*

## FUNGUS AND BACTERIAL DISEASES OF INSECTS AS FACTORS IN BIOLOGICAL CONTROL

IN an article published in *The Botanical Review** Dr. H. S. Fawcett of the University of California Citrus Experiment Station reviews some of the most important contributions on entomogenous parasites (fungi or bacteria parasitic on insects) in relation to biological control. He points out in the introduction to his paper that "in comparison with investigations of entomophagous parasites (insects parasitic on other insects), experimental work on entomogenous parasites in relation to biological control has received relatively little attention. Consideration of the latter subject, except for a few micro-organisms, has not gone much beyond the observational and descriptive stage, and only a small number of well-controlled experiments have been carried out. The reason for this appears to be partly that in the past period of extreme specialization this subject has become a kind of "no man's land" between the entomologist and the plant pathologist or applied mycologist."

"One apparent cause for neglect of the field has been the hasty generalization that because of failures to get outstanding results with certain fungi in initial trials, the whole field has little promise of practical results. Another is probably the preoccupation of both entomologist and plant pathologist with problems which they considered more closely related to their special fields. Mycologists, however, have in the meantime done considerable descriptive work on the occurrence and morphology of these entomogenous fungi."

The author in his article uses representative examples, mostly from entomogenous fungi and bacteria on the citrus insects, these being those best known to him.

His review of the literature† is summarized as follows :

"Entomogenous fungi range from species that possess a high degree of parasitism to those which are little more than saprophytes. Their effectiveness is influenced by conditions of moisture, temperature, agencies of distribution, migration of the insects and apparently by nutrition, density or other conditions of the insect host. The highly parasitic species appear to be important in bringing about a certain degree of natural control which in favourable, special situations amounts to

*The Botanical Review, X, No. 6, pp.327-348, 1944.
†All references to literature are here omitted.

satisfactory commercial control. Others less parasitic are of only minor importance, while still others are of doubtful value and may be little more than saprophytes.

The chinch bug fungus, *Beauveria globulifera*, as an example of a common widely distributed fungi, is reported on at least 60 species of insects and has abundant wind-borne spores. The failure to attain increased mortality by artificial distribution of this fungus has been often cited as an example of what may be expected from entomogenous fungi. It may be pointed out that this result might have been expected from a fungus of this kind which has many hosts and which produces such abundance of wind-borne spores that may become widespread and reach a "saturation point" under almost all conditions suitable for infection. What was found with this fungus is not necessarily a criterion by which to judge possibilities in other fungi.

The green muscardine fungus, *Metarrhizium anisopliae*, with similar characteristics as to wind-borne spores, has been used commercially for an early start of epidemics of froghoppers in Trinidad but failed to be of practical value on May beetles in Puerto Rico. There was probably a sufficient lag in spore saturation when used in the first case and more nearly saturation in the second.

In contrast, *Sorosporella* of cutworms produces neither external growth nor wind-borne spores and completes its development within the insect body, producing complete parasitism in 10 days by means of yeastlike bodies within the blood.

Among a number of fungi that parasitize the *Dialeurodes* or whitefly larvae, *Aschersonia aleyrodis* and *Aegerita webberi* are outstanding examples. Under conditions like those in parts of Florida these are spread artificially to increase their efficiency at certain seasons of non-saturation. Under certain conditions, these fungi without artificial aid appear to keep the insects at a low level and in some conditions to aid in producing commercial control. Differences in conclusions as to their value for artificial use may be due to trials under different degrees of spore saturation.

Among the fungi parasitic on scale insects, some of the most important are species of *Sphaerostilbe, Nectria, Podonectria and Myriangium*. In conditions of moist low-lying localities in Florida most scale insects in association with these fungi remain at a low level. It has been pointed out, however, from certain recent observations, that the efficiency of entomogenous fungi on purple scale cannot be entirely judged by the phenomenal increase of this scale by spraying with Bordeaux mixture or other residue-depositing mixtures. Non-fungicide residue-depositing mixtures also cause increases in purple scale. Other factors making it more favourable for their development appear to account for a considerable portion of this increase.

Species of *Aspergillus* and *Entomophthora* are discussed as important parasites on mealybugs, *Empusa* and *Entomophthora* on aphids, a species of *Spicaria* on cottony cushion scale, and one of *Rhinotrichum* and an undetermined fungus on mites.

Attention has recently been directed to bacterial parasites of insects through the success in the work with the milky disease of the Japanese beetle.

A spore-forming bacterium, known as *Bacillus C*, has recently been found capable under certain conditions of killing the California red scale. The susceptibility to attack appears to be increased greatly by the increase of nitrates in the substrate on which the insect feeds.

There appears to have been in the past a tendency to judge the possibilities in this line of investigation by the failure of some of the past experiments to show outstanding control. What is needed is to determine more definitely not only the rôle which these entomogenous fungi and bacteria play in natural control, but also to explore further the possibilities of increasing their efficiency by artificial spread in situations where the saturation point is not reached under natural conditions.

Much attention is being given to the discovery, introduction and artificial spreading of entomophagous insects and to finding ways of increasing their efficiency. The comparatively few that have given outstanding control have justified this large effort. Greater attention is needed in exploring the possibilities from similar work with various insect-destroying fungi and bacteria, and possibly insect-destroying viruses. More co-operative research by plant pathologists and entomologists should yield important results in this largely unexplored field."

## THE ALOES INDUSTRY IN MAURITIUS

The so-called aloe of Mauritius is not an aloe but *Furcraea gigantea*, a plant closely related to Agave. The leaves yield a hemp fibre which has some commercial value. The plant, introduced to the island from Brazil in 1750, is common, especially in waste places. Sporadic attempts have been made to cultivate it in regular plantations but little seems to have come of them until 1924, although cultivation is easy and cheap. In 1924 the Mauritius Hemp Producers' Syndicate was formed with the object of marketing a uniform product, to which end a central factory was established. This was followed by the Mauritius Spinning and Weaving Company founded in 1932 with the aid of a grant from the Colonial Development Fund to manufacture sacks from the local hemp. After a somewhat chequered history this Company is now in full operation, producing 3,000,000 bags between August 1941 and December 1943. The prime difficulties arise from the fact that only in a few cases is the plant cultivated and supplies have to be obtained from wild plants, mostly scattered and far from the factory. Suggestions are made as to the nutritional requirements of the plant based on analysis of the ash. A minimum yield of cultivated plants should be 575 kg. of dry fibre per arpent (1.04 acres). Local methods of preparing the fibre are also described.—(*Horticultural Abstracts*, XIV, No. 2, 1944.)

# CO-OPERATIVE CREDIT SOCIETIES IN THE SOUTH CARIBBEAN AREA

BY

A. R. STANIFORTH

*(Adapted from a dissertation presented in part fulfilment of the requirements for the Associateship of the Imperial College of Tropical Agriculture)*

## Introduction

In 1943 there were 25 co-operative credit societies working under Government supervision in British Guiana, 21 societies operated in the South of Trinidad under the supervision of the Usine Ste. Madeleine, and 62 credit societies in Trinidad and Tobago financed and controlled by Government. The writer visited the Usine Ste. Madeleine, British Guiana and Tobago in order to study the organisation of these three groups of credit societies which differs in important respects. The over-all financial progress and cost of running of each of the groups was investigated from central records; the exact method of operation of each group was examined; and from all societies' books, detailed working of each individual society for the last five years was extracted and analysed. The writer interviewed the secretaries of some fifty societies and attended a great number of society meetings in Trinidad and British Guiana.

It is held that, in modelling a West Indian system of peasant credit, it is more important to make a detailed study of any local examples of credit societies than to read the extensive literature on co-operative credit which is mainly concerned with the theory and general operation of the credit movements of different and distant lands.

In this article the achievements of these three differently organised groups of societies will be detailed and the contrasting principles and methods involved will be critically examined. Suggestions and recommendations will be made.

A visit was also paid by the writer to St. Vincent, and reference will be made to the causes of the failure of a once promising credit society movement there. Consideration of the large group of Jamaican societies would be very necessary to complete a study of West Indian co-operative credit.

In the belief that Co-operation should be embarked upon in no introspective spirit and that sound business policy should be the only aim, only the business aspects of co-operative credit will here be considered.

## General History of the Three Groups of Credit Societies

### *Trinidad and Tobago Government Financed Societies*

In 1916 the first Agricultural Credit Societies Act of Trinidad and Tobago was passed, providing for small societies (maximum membership 50) of unlimited liability, loans to be for agricultural purposes only and for not less than one year. In 1917 the movement was promoted in Trinidad when the Governor himself attended the first annual general meeting of the Diego Martin society. This society at first borrowed from private sources, but it soon became apparent that repayment was to be more difficult to arrange than lending, and bad debts occurred. Government had to be resorted to for all further loans and, since that time, all societies in Trinidad and Tobago, except those organised by the Usine Ste. Madeleine, have relied on Government for working capital. The rate of interest on these loans to societies, which have been of one year term since the earliest years, was 6 per cent. until 1939 and 3 per cent. subsequently.

The first Diego Martin society failed, but a new society was organised in the same district in 1919 under the name of the St. Lucian Agricultural Credit Society. No other society was started in Trinidad until 1926, but in Tobago there were ten societies working by 1920. These societies preceded their meetings with a prayer and a hymn and were uniformly reluctant to repay their loans. Comparatively large overdues accumulated in Tobago and business was practically at a standstill between 1930 and 1940, no further loans being made by Government during that period. In 1932 the present Inspector was appointed and the number of societies in Trinidad has increased steadily since then. There were 24 active societies by 1938 in Trinidad and in the 1942-1943 year 898 members of 35 societies in Trinidad borrowed $48,205 and between 400 and 500 members of 17 societies in Tobago borrowed $14,537. No new loans are normally granted until the previous year's loans have been repaid in full, and overdues have been kept comparatively small since 1939, when almost the last of the Tobago overdues were recovered. A total of some $300,000 worth of short term loans has been advanced to small farmers by Government between 1916 and 1942. The interest charged to members was 12 per cent. till 1939 and either 6 per cent. or 7 per cent. since then.

Seventy-five per cent. of all the loans made in the Trinidad societies and all the loans made in the Tobago societies of this group were classified in the 1942-1943 season. About three-quarters were for cultural operations including cane, cacao, rice and ground provision cultivation; rather less than a quarter was for the purchase of stock; and a very small percentage was for the purchase of buildings, implements or land or for repairs to buildings. No loans were granted for non-agricultural purposes.

*Usine Ste. Madeleine Societies*

In 1919 the Usine Ste. Madeleine came to the conclusion that credit societies, legally registered under the Trinidad Ordinance of 1916, would provide an excellent means of financing cane-farmers. 16 societies were at once set up, and the number has ever since been consistently near 20, with a membership around 800. Unlike the Government financed group, these societies until 1924 obtained money from Barclays' (formerly the Colonial) Bank after which they were financed by the Ste. Madeleine Company. This Company charged 6 per cent. till 1941 after which the rate has been reduced to 4 per cent. Members paid 2 to 12 per cent. on loans till 1941 since when 10 per cent., 8 per cent. or 7 per cent. has been charged by various societies. These societies have accumulated considerable profits and these contribute very materially to the working capital.

Big loans were made in the boom years after 1918 (*see* fig. 1)* and difficulties in repayment were met, similar to those in the Government financed societies, but on a much larger scale. In 1923 the societies owed the Colonial Bank $100,000 and loans had to be drastically curtailed. In 1924, $84,000 were still outstanding; but the Sugar Company, in return for an agreement by the bank that all interest on outstanding amounts should be waived, guaranteed to repay. In the following eight years $42,000 were recovered from the societies by drawing on reserve funds in the bank and by carrying out bailiffs' levies on members' securities while the Company itself paid the other $42,000.

After these early disasters, the societies have worked with great and level efficiency. On the average, some 700 cane-farmers have borrowed around $50,000 per annum. As can be seen from the figures, repayments have been kept consistently in line with loans made and overdues have been very small. Accurate figures for earlier years are unobtainable but, between 1927 and 1942 some $580,000 have been advanced. The Company inaugurated the movement with one supreme object in view—they wished to promote the growth of cane for their factory. Loans to-day are almost entirely for cane cultivation but, when mules are available, a few loans are granted for their purchase.

*British Guiana Societies (Known as Banks)*

The first Agricultural Co-operative Credit Ordinance in British Guiana was passed in 1914. It provided for limited liability banks of unlimited membership which could borrow from Government only up to the amount of subscribed share capital, and which were to lend "only and principally for productive agricultural or industrial enterprises which hold out reasonable prospects of profit . . . ". This is to be compared with the definite stipulation in the Trinidad legislation that loans shall be made only for agricultural purposes. As in Trinidad, loans were to be made for a maximum term of one year, but express provision was made for renewals and liberal use has been made of this provision. All Government loans to banks have been repayable in twenty-five equal annual instalments of principal and interest —the interest charged having been 6 per cent. per annum throughout. The maximum rate of interest on loans to members has been legally fixed throughout at 12 per cent. and banks variously charge 8 per cent., 10 per cent. and 12 per cent.

Banks' indebtedness to Government has never, in practice, been as high as share capital (fig. 2) but, between 1919 and 1922, $80,000 were borrowed from the Colonial Bank. Profits have accumulated till they now account for more than a quarter of the capital at the banks' disposal.

Most of the credit banks that are now working were set up during the last war, and the British Guiana movement thus got into its stride a few years before that in Trinidad and Tobago (fig. 1). The membership reached 10,000 in 1921 and has stood at about the same figure ever since. Share capital increased to $70,000 in 1921 and has since remained practically stationary. During the years following the last war very large lending operations were conducted, but repayments were allowed to lag and arrears accumulated. It should be stated here that the repayment by the societies of the instalments of Government loans has always been satisfactory, except in the period 1936-1938 when Government lost some $4,000 through bad debts. (The Colonial Bank lost $4,000 and shareholders some $8,000 at the same time). Nevertheless, Government loans were restricted after 1923 and were withheld altogether between 1928 and 1940. During these years, however the banks were still able to make annual loans of between $20,000 and $40,000—figures comparable with those made by the Usine Ste. Madeleine group and much higher than those for the Government financed societies in Trinidad and Tobago. Since 1940, loans have increased rapidly but overdues are being tolerated to a greater degree than in Trinidad and Tobago.

There was a considerable drift of arrears of repayment by members from 1920 onwards, loans out being always greatly in excess of loans made in any one year. These arrears, however were not in the main of very long standing, at any rate latterly. Of the $93,000 outstanding at the end of 1940, for instance, $39,000 were loans made in the same year, $20,000 loans made in 1939, $15,000 loans made in 1938, $13,000 loans made in 1937 and 1936 and only $6,000 represented arrears from as far back as 1925. These figures show that borrowers in British Guiana banks tend to hold their loans for two or three years instead of for the maximum legal term of twelve months. Some excuse for this is provided by the following information on the purposes for which loans are granted.

In the season 1942-1943 some 2,000 loans aggregating just over $100,000 were made and some 36 per cent. of all loans granted were for

*The figures illustrate on identical scales the financial progress of each group of society.

# FINANCIAL PROGRESS OF THREE GROUPS OF CREDIT SOCIETIES

(Fig. I)

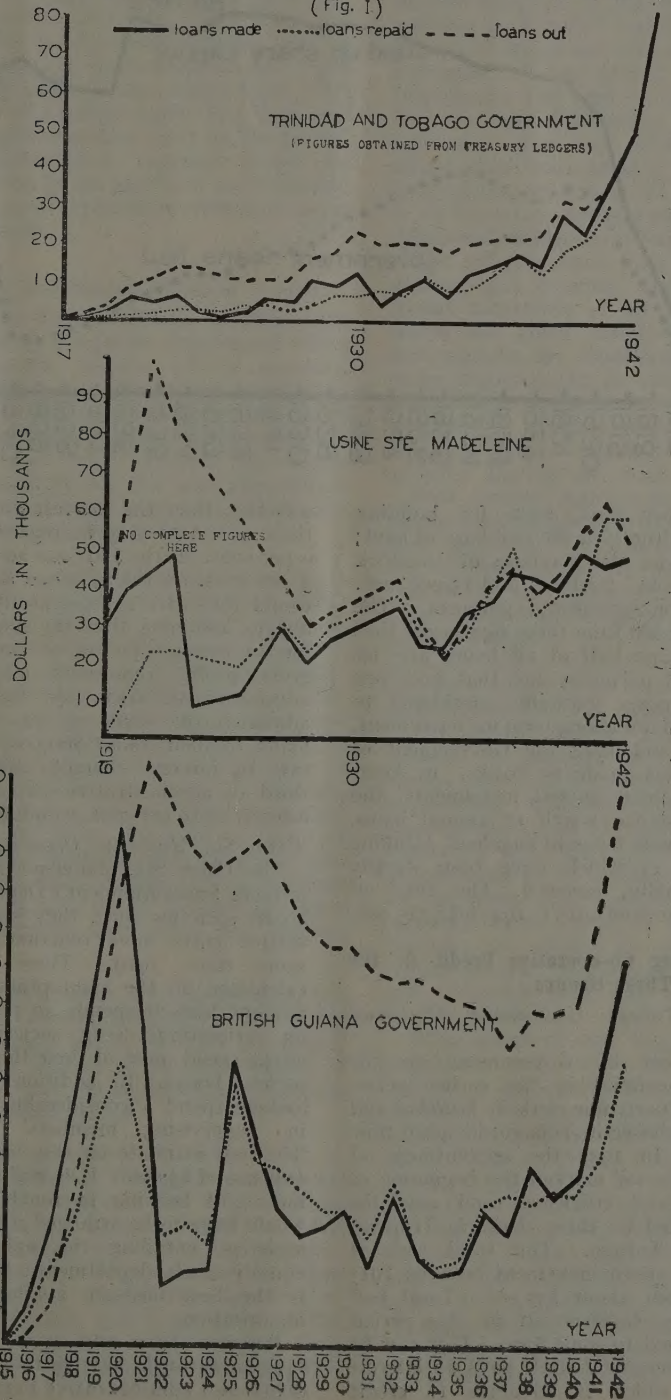
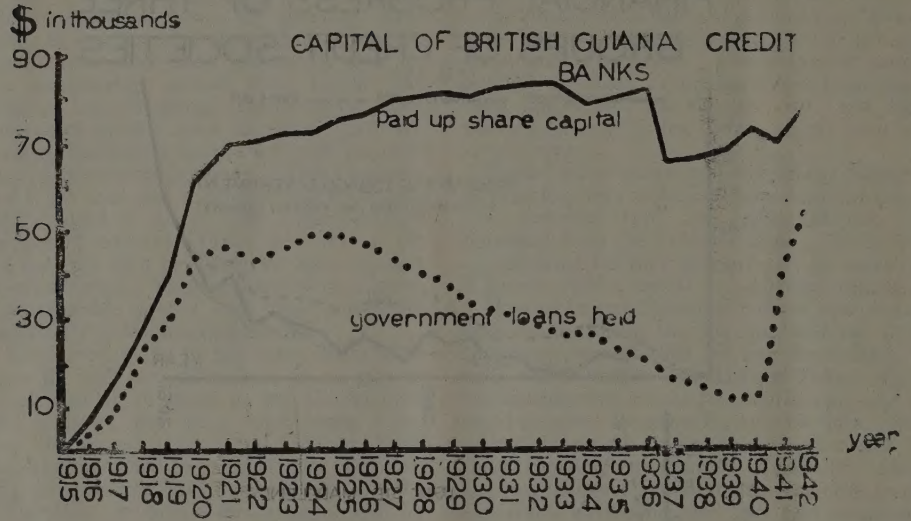


Fig. II




cultivations; 30 per cent. were for building (mainly non-agricultural) or the purchase of land; 21 per cent. were for the purchase of livestock including 'household' poultry; and 13 per cent. were for other non-agricultural purposes. The inferences to be drawn from these figures are that little more than one half of all loans are for purely agricultural purposes, and that fully one half are for purposes normally considered to require a medium if not a long term for repayment.

Between 1915 and 1942 the Government of British Guiana has made to banks, in loans repayable in 25 equal annual instalments, the equivalent of $859,000 worth of annual loans. The banks have made loans to members totalling $1,235,000 many of which have been tacitly though not formally, renewed. The total of loans held each year from 1915 to 1942 is $2,725,000.

**Cost of Organising Co-operative Credit in the Three Groups**

*Trinidad and Tobago Government Organised Societies*

Little was spent by Government on the organisation of societies in the earlier years. Until 1932 only a part-time clerk in Trinidad and the agricultural adviser in Tobago, in spare time were concerned. In 1932 the appointment of a whole-time Inspector marked the beginning of greater activity and efficiency, and now the Inspector is assisted by three clerks in Trinidad and by one in Tobago. The total cost of administering the credit movement between 1917 and 1942 has been about $35,000. Total bad debts incurred by Government in this period have only amounted to some $300. If it can be assumed that Government itself pays no interest on the money which it advances to credit societies, then the interest which it receives on these advances may be regarded as gross profit. 6 per cent. on the $190,000 advanced till 1939 and 3 per cent. on the $110,000 advanced since then would thus give a gross profit of nearly $15,000, always assuming that the money is out on loan for an average period of twelve months. This gross profit represents less than half the administrative costs for the period. In 1942 administrative expense was about $6,000 and loans totalled about $60,000. The 3 per cent. rate of interest charged recovered less than a third of administrative expenses—to do which interest at 10 per cent. would have been necessary.

*Usine Ste. Madeleine Organised Societies*

The Usine Ste. Madeleine has used the Cane-farmers' Superintendent's Department to supervise credit societies since they started and administrative costs have remained substantially the same since 1919. These costs have been calculated on the assumption that the Superintendent himself spends 40 per cent. of his time on agricultural credit societies, while his two clerks spend most of their time on the keeping of society books. In addition nine farmers' overlookers spend a considerable part of their time in supervising members' cane cultivations. The best estimate on this basis gives an annual expense of $5,000. It is realised that some other means of keeping in touch with cane-farmers would have to be arranged if there were no credit societies, entailing the upkeep of a perhaps equally costly department; but the above figure is the best measure available of the cost of organisation.

Between 1919 and 1927 the Company lost $42,000 through having to repay societies' bad debts, and administrative expenses for this period

may be put at $40,000. No accurate figures for loans made are available, but that was clearly a very expensive eight years for the organisers, the Company having to spend at least the equivalent of 25 per cent. of the total loans made. Between 1927 and 1942 administrative costs have been about $80,000 and bad debts have not occurred. While the Company actually gets no return in interest, one may calculate that 6 per cent. on the $580,000 loaned during these years would amount to $34,800—again less than half the estimated administrative costs for the period. In 1942 administrative expenses could be estimated at about $5,000 and loans made totalled some $50,000; again expenditure represents 10 per cent. of loans made.

*British Guiana Government Organisd Societies*

Since 1917 the British Guiana societies have been supervised by a separate department which has kept accurate records of its expenses. Practically nothing was spent on supervision in 1915 and 1916 but accurate figures show that annual Governmental expenditure on organisation between 1917 and 1942 remained practically stationary at about $5,000, the total expenditure for the whole period being some $125,000. $4,000 have been lost through bad debt.

The 6 per cent. charged by Government on total loans made (equivalent to $859,000 worth of annual loans) brought in about $52,000, considerably less than half the expense incurred in administration plus loss through bad debt. But, if the Government of British Guiana, while maintaining the same supervising staff, had supplied the total working capital of the banks then the income from interest on the total of loans made would have amounted to $74,000, (6 per cent. on $1,235,000) if these loans had been repaid in one year. In practice, many of the loans were for medium term purposes, and 6 per cent. on the total of loans out to members each year ($2,725,000) would amount to about $164,000—considerably more than the expense of supervision.

These latter calculations are hypothetical, but they show that Governmental supervision of the British Guiana credit banks was only about half as expensive, *in relation to the total volume of business done*, as was the supervision of societies in both the Trinidad groups.

In 1942 the supervision of credit banks in British Guiana cost $4,800, the banks' indebtedness to Government was $54,000, the total of loans made by societies was $104,000; and the total of loans outstanding at the end of the year was $151,000. Government actually received 6 per cent. on the $54,000—nearly three-quarters of administrative expense, and 6 per cent. on the total of loans outstanding would amount to a sum almost double the administrative expense.

**Present Organisation and Method of Working of the Three Groups of Credit Societies**

*Government Organised Societies in Trinidad and Tobago*

The Director of Agriculture, whose office is in Port-of-Spain, is the Registrar of all credit societies in Trinidad and Tobago, and copies of important forms and correspondence have to be forwarded to his office. An officer of the Department has been made Inspector of Credit Societies, and this officer really supervises the movement from his office in San Fernando, round which town most of the societies operate. But the Inspector must act through the Registrar in all important matters and there are inevitable delays and difficulties in liaison.

The societies have their own chairmen, committees and trustees, and unpaid secretaries. About two-thirds of all secretaries, a few of whom are given honorariums from members' subscriptions, are small farmers and the rest are either schoolmasters or village artisans. Societies have memberships of between 17 and 50 and average 31. On the average, two-thirds of all members are of East Indian descent, some societies having all 'East Indian', others all 'West Indian' memberships, and others again having varying proportions of each 'race' among their members. There is no correlation between the efficiency of society working and the racial constitution of membership. Society offices are usually in private houses and the accommodation is often extremely primitive. Meetings are often held in school-rooms, but sometimes the shade of a flamboyante serves as a meeting place, and a few societies have built themselves 'carat' roofed 'tents'.

The annual general meeting may be held without the presence of a Government official except when it is the occasion for loan sanctioning or granting. Attendances approach the statutory three-quarters quorum only at meetings directly concerned with the application for or granting of loans, and on the average, only 58 per cent. of all members have attended annual general meetings during each of the last five years. Societies are advised by the Inspector to hold regular monthly meetings, but such meetings are not commonly held and, when held, are very badly attended.

When members hope to get loans, the society committee will call a meeting or meetings; individual application forms will be made out on which the amount asked for, the purpose for which it is required and the security offered are noted. This security is further noted and valued by the applicant on a valuation form and an inspection committee, appointed by the society and paid from society funds, will later visit the applicant's holding and their valuation is also noted on the form; the figures may be checked again, if necessary, by the Inspector. When the applications have been dealt with, the Inspector is asked to sanction loans at a further meeting of applicants.

No new loans can be sanctioned to societies until the members have repaid in full all previous Government loans, except in extraordinary circumstances. As societies are almost completely dependent on Government for their funds, this means that only one loan can normally be made to members each year; and, since societies cannot hold any large sums of money, this one loan must be made in a lump sum. In 1942-1943 the Inspector, as a basis for lending, took the cost of cultivation of one acre of canes to be $24 and of one acre of ground provisions or rice, $40—purposely extremely conservative estimates. He would sanction loans only up to half the cost of these cultivations. In considering loans for other purposes, a man's previous loans and repayments, his expected yields and the nature of his security are carefully noted. In this matter, society committees of management and inspection do valuable work, which, in the absence of machinery such as one finds on the Usine Ste. Madeleine estates, could hardly be economically done in any other way. By the time the loan is granted, three application forms, three agreement forms, two charge on crop forms and one property valuation form must have been filled in for every loan made and these nine large forms must later be checked in the Inspector's office, one copy of each form being filed there, and other copies being variously distributed to the Registrar's and to the Societies' Offices. Needless to say, the filling in of all these forms is an extremely laborious task for the usually not scholarly honorary secretary. No separate fund is made available by Government for society operations but a maximum vote, which reached $150,000 in 1944, is annually passed.

A society's loan application travels to and fro between a number of Government offices before a voucher for the required amount is eventually sent to the Inspector. A day is fixed for a meeting of loan applicants at which the voucher is handed to the trustees, who make all haste to the nearest Treasury or warden's office and return to hand out the money to members. In Trinidad, in the 1942-1943 season, this process involved delays varying from 26 to 77 days, and averaging 36 days, between societies applying for and receiving loans. In Tobago the delays averaged about a fortnight more. Since this date loans to societies are made within 15 days.

Figures obtained from the completed valuation forms of 31 societies in 1942 show that the property offered as security for loans by all these societies was valued at ten times the value of the loans made. In no one society was the coverage given valued at less than six times the amount of loans made.

During the last five years the average loan per borrower in the Trinidad societies of this group has ranged between $152 for the Balmain society (whose members obtain loans nearly twice as big as members of any other society) and $18 for the Tortuga society, the average loan per borrower of all societies for this period being $52. The average proportion of society members to borrow during each of the last five years, which seems to give the best possible measure of society efficiency, ranges from 100 per cent. in the Balmain society to 17 per cent. in the Saint Lucien society. Ten of the 23 societies which have been working for the last five years have an average proportion of borrowers over 70 per cent., but eleven societies have proportions lower than 50 per cent.

The supervision of loan utilisation is left to the society, and the members, since they know that new loans will not be forthcoming next year unless the present year's loans are repaid, will tend to do something to see that money is not squandered. An informing letter, which may, however, be the result of private animosity, is appended. Close and effective supervision of loan utilisation is hardly practicable when loans are made in one lump sum and not in small amounts as needs arise.

*Copy of a Letter sent by a Member of a Society to Inspector*

"Sir,"

"I beg to state to you that J..... A.....apply for $60.00 but he is only the owner of a second hand cart and a half dead donkey with two lame feet, the garden he state to the member who value same is false its another man's own. The old house only value $20.00 and it is not in his name. I beg to look after this matter before giving him the loan".

Repayments are generally made to society secretaries during and after crop time and receipts must be given at once. The secretary must take all accumulations of cash over a fixed sum (usually about $15) to the nearest warden's office or treasury, where he will collect a receipt, and the money drains back in this way to Port-of-Spain Government Treasury. The secretaries' journeys to deposit accumulated cash must often be comparatively long and expensive. Many secretaries' book-keeping consists almost entirely of keeping their receipt book counterfoils and the receipts which they are given, and practically all the accurate book-keeping must be done in the Inspector's office although, officially, the Inspector is merely auditor of society books. All secretaries have rough notes on scraps of paper; some make attempts at keeping the books provided and only succeed in spoiling the pages; only one secretary has ever handed in his ledger and cash book properly made up and he had eventually to be expelled from his society for converting society funds.

By the end of August most societies which hope to obtain a further loan will have repaid all or most of their previous loan, if they can possibly do so.

In cases of default, procedure is simple. A bailiff in possession of the registered charge on crops, can at once seize all the charged property. Fourteen levies of this type have been made in the last five years. A few bad debts have occurred in which charged property could not be seized, but in these instances the small amounts

have been made good from societies' accumulated profits and no use was made of the principle of unlimited liability. A *pro rata* levy on all members to wipe out an otherwise irrecoverable debt has never been made in these societies.

The average running expense per member over the last five years has ranged between $2.16 for the Charlieville society and 38 cents for the Macaulay Road society, the average for all societies being $1.09. Secretaries' travelling expenses when depositing money account for a very considerable proportion of this expense; trustees' travelling expenses, remuneration for inspection committees and the cost of stationery account for some, and losses due to bad debt have also increased the expense of running of a few societies, among them Charlieville. The average running expense of all societies in this group, expressed as expense per borrower would be $1.85 or about 3½ per cent. of the average loan per borrower. Since these societies lend to members at either 3 or 4 per cent. more than they pay to Government for the use of the money, they have clearly on the average been making no profit whatever during the last five years. The societies have, in fact, very small accumulated reserves. The Charlieville society, the best from this point of view, has been operating for 12 years (longer than most societies) and had accumulated by 1943 a reserve fund of $220 and a cash balance available for lending of $290 (almost all during the years when interest charged to members was 12 per cent., 6 per cent. more than was paid to Government) but, on the average, the societies in this group had reserve funds of only $104, and not only had they no cash balance in hand, but they showed an average debit balance of $156. Against this, the societies were owed by their members in 1943 an average of $281.

*Usine Ste. Madeleine Societies*

These societies are registered under the Government ordinance and the Director of Agriculture is Registrar. The group however borrows no money from Government and functions in almost entire independence, being maintained and organised by the Usine Ste. Madeleine Sugar Company. The Company's cane-farmers' superintendent has complete control over the group, being honorary secretary and treasurer of all societies and officiating as the only active trustee. The societies have chairmen and committees who act, when necessary, between the cane-farmers' superintendent and members. Memberships vary from 20 to 68 (on special application to exceed 50), over 90 per cent. of all members being of East Indian descent. Only two societies have any considerable proportion of non-East Indian members.

The annual general meeting of the society is called, usually in an estate building or a school-room, and members know from experience that business will not be done unless the statutory three-quarters quorum is present, and present on time, to answer the roll when called by the secretary. Minutes are read, the statement of accounts is given, new members are elected and the committee of auditors are agreed upon. Entrance fees and rates of interest are decided, and the maximum society loan of one year term for the coming season is voted; all these proceedings being conducted in the most orderly manner by the honorary secretary, who always dominates, though he does not officially chair the meeting. On the average, there has been an attendance of just over 75 per cent. at the annual general meetings of all these societies during the last five years. No attempt is made to encourage monthly society meetings when there is no financial business calling for such a meeting.

Within a few days of the annual general meeting the committee of the society will meet usually without the secretary, to consider members' applications for loans. Approved applications together with information as to security offered, are sent by the chairman to the secretary who, by reference to a man's previous record and to his cane production as shown by the estate returns, can check the validity of the application. Full repayment of previous loans is not insisted upon before new loans are granted. Indeed, after the very wet cane harvest of 1938, which led to incomplete loan repayment, loans were increased in 1939. Having approved loan applications, the secretary asks the Company cashier to make out a cheque for the total amount involved. He arranges a day to meet the applicants and the committee of management. On that day, acting as trustee, he cashes the cheque at Barclays' Bank, takes the money out and, in return for single copies of the loan application and loans agreement forms and for two copies of the charge on crops, distributes it to the applicants. One copy of the charge on crops is sent to the Registrar for registration, the rest being kept in the secretary's office. The time between the application for a loan and its granting will seldom be more than a week. A number of applications from any society up to its voted maximum may be dealt with at any time when money is required by members for cane cultivation. Indeed, the cane-farmers' superintendent prefers to lend in several instalments for planting, first cleaning, second cleaning and for subsequent cultural needs as they arise. He considers that loans are then less likely to be used for purposes other than those stated on the application forms.

During the last five years the average loan made per borrower has ranged from $133 in Debe society to $24 in Union Hall society, the average loan per borrower in all societies during this period being $69. The average proportion of society members to borrow during each of these five years has varied from 98 per cent. in the best to 46 per cent. in the worst, but in only two of the twenty societies has the proportion of members to borrow been less than 70 per cent. and the average of all societies is 80 per cent.

The borrowers' cane crops are regarded as the best possible security, and no loans are made to members unless adequate security in canes is

given. When borrowers' canes are harvested, the secretary sends to the office of the estate in question a list of amounts loaned to the various cane-farmers who must bring their canes to that estate's scales. In 1942-1943, when the advance payment for canes was $3.80 a ton, it was customary to deduct $2 per ton, and this amount was noted in a "deduction book". The honorary secretary of the society who is the cane-farmers' superintendent, arranges the deduction and he makes out a receipt for this amount for each cane-farmer concerned, sending it back to the estate office in time for it to be included in the farmer's fortnightly pay packet. This procedure is continued until the loan and interest are paid off. All the book-keeping is done in the Company's offices. The members of Lengua, one of the best societies, in which a self-respecting mohammedan class predominates declared that they would prefer to make cash repayments in person, rather than have repayments made by the deduction system. They were allowed to do so and, up till now, this system has worked very well.

Clearly the mechanism generally operating in this group gives the best possible guarantee that loans will be repaid, and for the last 15 years repayments have been kept very closely in line with loans made. But even in this system loans have occasionally become irrecoverable by the normal means and there have been five levies on defaulting members' pledged property during the last 14 years; and there have been seven instances within the same period of *pro rata* levies on all members of a society, when one member's bad debt has been otherwise irrecoverable. Such a use of the principle of unlimited liability is comparatively simple when deductions can be made from other members' pay sheets, and is considered to encourage members to watch loan utilisation more carefully.

The average society running expense per member over the last five years has ranged between 87 cents for Williamsville society and 23 cents for the Garth society, the average for all societies being 50 cents, stationery and correspondence accounting for most of this. The average running expense, expressed in cents per borrower, would be 63 cents or nearly 1 per cent. of the loan per borrower. Since these societies lend to members at between 3 per cent. and 6 per cent. more than they pay for the use of borrowed working capital, they can, on the average, make between 2 per cent. and 5 per cent. profit on such capital. They make much more on their own accumulated profits which they use for lending. The result of this economical working is shown in the figures for societies' accumulated profits. Malgretout society, with $3,581 of accumulated profits available for lending, had arrived in 1943 at the ideal position of being entirely independent of borrowed capital. These societies averaged nearly $1,000 of accumulated profits in 1943, nearly $700 of this being cash available for lending, the remainder being invested in reserve funds.

*British Guiana Government Organised Societies*

A Credit Bank's Board has supervised this group of cooperative credit "banks" during the last ten years. The secretary of the board is the Registrar who also fulfils the functions performed by the Inspector in Trinidad, spending all his time on the direction of the movement and the auditing of the banks' books in his Georgetown office. This office is in the Agricultural Department buildings, and the Director of Agriculture is the chairman of the Credit Banks Board.

Societies are run by a committee of members, with a secretary paid out of society funds, and chairmen who have all been officers of the Department of Agriculture during recent years. The biggest bank, Essequibo, had a membership averaging 1,189 during the years 1938-1942; the smallest, Vergenoegen, has had a membership of 126; and the average of all banks has been 453. Of these almost exactly one-third are of East Indian descent, and while there are some East Indians in all banks, in only three is there a greater number of East Indians than others. There is no clear correlation between the efficiency of these banks and the racial constitution of their memberships. Most banks have rented offices which open at stated times during most days of the week and which resemble and operate like places of business. A number of the secretaries have experience of business methods and some are capable typists. They receive salaries of between $100 and $600 per annum and the auditing of their books is often straightforward, not entailing complete re-entries. A large quorum at meetings is not demanded by society rules and only a small fraction of members attends the annual general meetings.

Committee meetings, normally attended only by committees and applicants, are held in the offices every month under the chairmanship of the agricultural officers, and applications for loans are considered. On one side of a form the applicant must state the purpose for which he needs the loan and the security he is prepared to offer (or which surety is prepared to offer for him). The number of shares held must also be stated, but the old stipulation that loans could only be made up to twice the applicant's share holding has been waived since many shareholders have stopped borrowing and since the societies have accumulated considerable reserves. When an application has been approved, the secretary and chairman, who act as joint trustees, can, on their two signatures, withdraw sanctioned amounts from the Post Office Savings Bank which is nearly always at hand in the big villages of British Guiana. Sanctioned amounts are granted by the chairman after he has witnessed the applicant's signature to a promissory note printed on the back of the application form. Loans may be granted, in this way, on the same day as they are applied for (unless security has to be inspected) and only the one form is used. Societies' working capital is kept in the Post Office Savings Bank and, so long as funds are available, money may be withdrawn for lending

at any time. In practice, loans are made equally in all months of the year. Should any bank's cash available for lending run low in the Post Office Savings Bank, the Credit Banks Board and through them, Government, may be approached with a request for a further loan. Normally the bank will receive such a loan about two months after an approved application has been made, but this delay does not hamper the Bank's activity, as do similar delays in Trinidad, if the committee of management uses sufficient foresight to apply before their funds run too low.

These banks make uniformly small loans. During the last five years the highest average loan per borrower has been $69 (in the Skeldon bank) and the lowest has been $26 (in the Hopetown bank), while the average loan per borrower for all these banks during the five year period has been $39. The average proportion of members to borrow during the last five years in these banks has ranged from 37 per cent. in the Georgetown bank to 7 per cent. in the Friendship bank, the average percentage in all banks being 15. As has already been indicated, loan repayments are slower than the legal maximum length of term of one year should warrant, but not much slower than one would expect in view of the purposes for which loans are granted. During the last five years, the average amount of loans out per borrower ($92) in all banks has been 2.4 times as much as the average loan made per member ($39) in those years, indicating that loans are habitually held for an average of nearly two and a half years. In the Georgetown bank, on the average over these five years, rather less is out to members at the end of the year than has been loaned during the year, indicating that loans in this bank are of an average length of term of slightly less than 12 months. The Ann's Grove-Clonbrook bank is much the worst in this respect with loans habitually out for five years.

The procedure in cases of default, which are not very common, is more difficult than in the Trinidad societies. The promissory note supplies the only legal hold over borrowers and a court judgment must be obtained against any defaulter before action can be taken. However, the Ordinance of 1933 provides that loans to members shall constitute a preferent claim on borrowers, property, and coverage given by the form used is found adequate, it being considered in British Guiana that the publicity attached to a court case acts as a powerful deterrent to possible defaulters.

Running expenses in these banks have ranged on the average over the last five years between 72 cents and 30 cents per member and averaged 50 cents per member for all banks. This average expense could be expressed as $3.33 per borrower or nearly 3½ per cent. of the average amount outstanding per borrower per annum. These banks lend at around 10 per cent. to members—4 per cent. more than they have to pay on Government loans—so they can on the average make very little profit on lending capital derived from Government. The banks pay dividends on share capital of between 2 per cent. and 6 per cent. according to circumstances, sometimes paying no dividend at all; so they can make a fair profit on lending capital derived from shares. On lending capital derived from accumulated profits they should make very considerable profits. In fact, all but two of the banks accumulated, by 1943, profits amounting to more than $1,000 each (the Essequibo bank has $6,158) and the average of accumulated profits per society in 1943 was $2,660. Of this, however, $1,228 were in the form of reserve funds invested in Government securities and only $1,432 were available for the banks' lending operations. In addition these banks have an average of $500 each of dividends so far unclaimed.

(*To be continued*)

## LEY FARMING

"Alternate Husbandry", issued as Joint Publication No. 6 by four of the Imperial Agricultural Bureaux (Aberystwyth. 5s.), has been compiled by a number of authors, each of whom deals with different aspects of the subject. It is emphasized that the use of leys in rotation under a wide range of climatic and soil conditions and in combination with a great variety of crops is a question upon which much research is needed, and that the purpose of the publication is largely to provide a basis for that research. The system is flexible, but cannot be applied to all types of agriculture, it being unsuitable, for example, in semi-arid or wet tropical regions where problems of establishment and management multiply considerably. The publication opens with a geographical review in which the trends of development in the practice in fifteen different countries and regions are described. Later chapters deal with the question in more detail, showing among other matters that the type of ley selected depends largely on the climatic factor, and that a closer study of the root systems of herbage plants is required before the effect of the various species and their different combination on the soil can be properly assessed. It is generally recognized that a ley is a method for improving the structure of the soil, as it increases granulation, which both benefits the crop and helps to prevent erosion. Other problems such as weed control, soil conservation, plant health and the economic factors involved in the system are also discussed. As regards the animal crop many factors are involved; but it seems likely that the regular ploughing of grassland will reduce the liability to disease even in spite of increased concentration of stock. For those requiring more detailed information, a list of more than three hundred references are arranged in groups appropriate to each chapter.—(*Nature*, Vol. 154, No. 3903, 1944).

# HEDGE PLANTS IN NORTHERN NIGERIA

BY

W. E. T. Bond, B.A., A.I.C.T.A.
(*Department of Agriculture, Nigeria*)

Hedge plants used in Northern Nigeria can be divided roughly into two categories:—

(i) *Shrubs or Short Plants* which are planted closely with the object of forming a hedge impenetrable to man and beast.

(ii) *Live Stakes* which are planted in rows usually not more than a yard apart, and to which mats, stalks of corn or wire can be tied to form a fence. On Government farms these are used to support wire netting or wire to form a stock and game-proof fence.

## 1. Shrubs or Short Plants

The following short shruberry plants are used by the natives and have been used by the Agricultural Department with varying degrees of success.

**1. Euphorbia balsamifera** Ait. (Hausa: aguwa, Alyara). A shrub which branches close to the ground and rapidly forms a thick hedge in areas with 35 inches of rainfall or less, especially where there is a good depth of sandy soil. Planted from cuttings not known to form seed in Nigeria although it does flower. Does not form a stockproof hedge on its own, but with attention, supplying and filling the gaps between plants with dead thorns, is one of the most effective hedges so far found for the low rainfall area. Relatively immune to attack by white ants. Not eaten by stock.

**2. Euphorbia lateriflora** Schum. & Thonn. (Hausa: fi da sartse). A dense shrub whose stems are leafless except when young. When well grown is almost impenetrable, but is not so easy to establish as *E. balsamifera*, and grows rather less rapidly. Optimum soil and climatic conditions are the same. Not eaten by stock.

**3. Euphorbia kamerunica** Pax. (K'erana) and other cactiform species are used by the Pagan tribes on and around the hilly country of the Bauchi Plateau 4,000 feet above sea level, and of the Cameroons. Old stockades and fences round the farms that have been well cared for and supplied are absolutely impenetrable. It probably requires at least 50 inches of rainfall for good growth and I have never seen it well established as a live fence away from the hilly country. Not eaten by stock.

**4. Lawsonia inermis** Linn. (Henna—Hausa: *lalle*). Can be established from seed and will form a thick impenetrable hedge but only when cared for and frequently cut back. Left uncut will grow tall and cease to be stockproof. It will grow where the rainfall is as low as 30 inches, but not in a poor soil. Not often used as a hedge, but rather planted at intervals along the boundaries of, and across farms. The leaves are used for dyeing the fingers and toes. Not normally eaten by livestock.

**5. Furcraea gigantea** Vent. (Mauritius Hemp). Has been used successfully as a farm boundary where the rainfall is 40 inches or more. When planted in a double row and well grown is stockproof. It has the disadvantage that after a number of years, it forms a "pole" or flowering stem, after which the plant usually dies, so that it does not form a permanent hedge unless supplied. It will not survive the dry season where the rainfall is much lower than 40 inches per annum. Not eaten by stock in Nigeria.

**6. Agave amaniensis** (E. African Sisal) has been tried but does not grow so well as *Furcraea gigantea*.

**7. Parkinsonia aculeata** Linn. (Jerusalem Thorn—Hausa: sassabani). Grows well in areas with rainfall to below 20 inches per annum and can be used as a stockproof fence only if kept cut back. If allowed to grow it becomes very gappy. Not eaten by stock.

**8. Ziziphus jujuba** Lam. (Jujube tree—Hausa: magarya). Not recommended as a live hedge as the stems form underground suckers and invade farm land. Cut stems make a formidable thorn enclosure for cattle or around farms. Grows well in areas of very low rainfall. Eaten by livestock.

**9. Jatropha Curcas** Linn. (Physic nut—Hausa: bi ni da zugu). A very common hedge, but not proof against small stock. Grows well under as little as 30 inches rainfall, and is resistant to white ants. Not eaten by livestock.

**10. Citrus aurantifolia** Swingle (Acid Lime—Hausa: lemu). Planted from seed in a nursery and transplanted the following year will form a stock proof hedge only if given attention for the first year or two. Cannot survive in a shallow soil, but in a deep fairly good soil grows well with as little as 35 inches rain per annum. Needs cutting to prevent it growing into a tree. Not eaten by livestock.

**11. Opuntia Dillenii** Haw. (Prickly pear). Has been tried but with no great success as it is susceptible to attack by white ants and does not tolerate extremely low humidity of the air during the long dry season. The spineless form is not relished by Nigerian cattle.

**12. Acacia albida** Del. *A. senegal* Willd., *A. campylacantha* Hochst and others have been suggested as suitable thorn hedges, but trials have shown that they take so long to become established that it would take at least 10 years to grow a hedge from seed. All are eaten by livestock in spite of the thorns, but usually survive in spite of this.

**13. Balanites aegyptiaca** Del. (Desert date—aduwa). Might be used as a thorn fence in areas of low rainfall. It grows more quickly than most thorns but is liable to form suckers. Not eaten by livestock.

**14. Garcinia Sp.** *Gamboge* planted either from seed or stakes makes quite a good hedge where the rainfall is 40 inches or over, but needs a fair depth of soil. When kept cut back and well supplied it is stockproof. Not eaten by livestock. Resistant to termites.

### 2. Live Stake Plants

**1. Commiphora africana** Engl. (African myrrh : Hausa: dashi). This can also be used as a hedge, but owing to its tendency to grow tall it has not been found to be very efficient in keeping out small stock. Large or small stakes, planted just before the rains will take readily in areas where the rainfall is even below 30 inches, but in shallow soils or heavy land inclined to water logging, it is liable to attack by termites. Leaves eaten by livestock.

**2. Commiphora Kerstingii** Engl. (Hausa: ba-zana). Very often used as a live fence in towns and at Zaria (rainfall about 45 inches per annum) has so far been found to be the most effective live pole to which to attach wire netting. Large poles planted before the rains are almost certain to take. Leaves eaten by livestock.

**3 Boswellia Dalzielii** Hutch. (Frankincense tree —Hausa : ararra'bi). Is being used at Zaria in the same way as *C. Kerstingii* but does not grow so rapidly. It has a natural range which extends further north into areas where the rainfall is only 30 inches. Leaves not usually eaten by livestock.

**4. Moringa pterygosperma** Gaertn. (Horse-radish tree—Hausa : zogallagandi). Can be planted either from seed or stakes, and will grow where the rainfall is as low as 20 inches, and is very often used as supporting poles for compounds. The young leaves are used as a vegetable, and are also very much liked by small stock which makes it difficult to establish from seed. It is unfortunately shallow rooted and especially in light soils liable to blow over in a strong wind. It grows rapidly and forms erect unbranched stems.

**5. Ficus thonningii** Blume (Hausa : che'diya) and *Ficus polita* Vahl. (Hausa : durumi). Have both been used as live poles but grow into trees which cast a heavy shade. Susceptible to attack by white ants. Leaves eaten by livestock. Will grow in good soil with as little as 20 inches of rain.

**6. Newbouldia laevis** Seem. (Hausa : aduruku). Planted from stakes will grow 20 or 30 feet high with little or no branching. Grows well where the rainfall is 40 inches and over, and is used very commonly as a fence round compounds. At Zaria, it has been found unsuitable for use as a live fence round crops or grassland owing to the great distance that its roots spread a short distance under the surface of the soil reducing yields. Leaves not eaten by cattle.

**7. Azadirachta indica** A. Juss (Neem). A fast growing tree suited to deep sandy soils and 25 to 35 inches rainfall per annum. Casts a light shade and can be used as live poles, but at Zaria, it too has been found unsuitable for the same reasons as *Newbouldia laevis*. Susceptible to termites and difficult to establish from seed as it loses its viability quickly. Leaves not usually eaten by cattle.

**8. Dalbergia Sissoo** Roxb. A fast growing tree suited to well drained soils. Sets seed freely and grows well with as little as 25 inches rainfall per annum. Under favourable conditions a live fence can be established from stakes planted in the middle of the rains. Will not tolerate heavy or waterlogged soils. Casts a light shade and has been used successfully as a support for wire in fencing a paddock. Rather liable to termite attack. Leaves eaten by goats not cattle.

**9. Cassia Siamea** Lam. A fast growing tree which does well in Northern Nigeria under almost any conditions ranging from 20 to 50 inches rainfall per annum. Sets seed freely and has been established at Daura (rainfall about 30 inches) as a fence *in situ* in 3 years from seed. It must be closely planted in well manured soil and protected against goats until 4 feet high. Leaves not normally palatable to stock but are eaten at the end of the dry season when fodder of any kind is very scarce. Relatively immune to termites.

**10. Glyricidia maculata** H.B.K. Grows very quickly from stakes at Zaria and Ilorin (rainfall about 45 inches). Cut to 6 feet encourages branching. When layered it should make a cattle proof fence if closely planted. Leaves not readily eaten by Nigerian cattle.

### Root Systems of Plants Used as Live Poles

**A. Newbouldia laevis** Seem :

Nearly the whole of the Botanist's farm at Samaru, Zaria, is enclosed with wire netting supported on live poles of one species or another. Some years ago it was noticed that some of the plots yielded very poorly at the edges, and as a result a grass strip 9 feet wide was left uncultivated round all plots where there was a live fence. Even so crops still continued to be very patchy for some considerable distance into the plots and in 1941 ditches 2 feet wide and 2 feet deep were dug round the plots 9 feet from the live fences, with the object of cutting any roots that might have spread into the plots. In spite of this, in 1942 and 1943 crops including groundnuts, soya beans and introduced grasses were still very patchy for a considerable distance from the edges.

During the 1943-44 dry season it was noticed that 44 young *Newbouldia laevis* shoots about 1 foot high were growing from the side of the ditch furthest from 180 feet of wire fence supported on live poles of the same species. Dissection *in situ* of the root systems of these young plants showed that the green shoots had arisen from stumps of roots cut off from the *Newbouldia* in the fence when the ditch was dug in 1941.

In one case the root had two branches 16 feet and 11 feet long respectively stretching far into the plot and lying on the average about 6 inches below the surface of the soil. A second root system had three branches, 6 feet, 6 feet and 9 feet long respectively. The dissection was done when the soil was very dry, so it was impossible to trace very fine roots. The furthest distances two of the roots had spread from the plants they originally came from, *i.e.*, in the live fence, were 20 feet and 26 feet, measured in at right angles to the line of the fence. The actual lengths of the roots were 22 feet and 27 feet respectively.

This particular live fence consists entirely of *Newbouldia laevis*, and the patchiness of crops grown in the plot from which the roots were dissected has been particularly noticeable for several years. Plots bordered by live fences

containing other plants together with *Newbouldia laevis* suffer from similar patchiness. It is therefore concluded that the roots of *Newbouldia laevis* spread a great distance running about 6 inches below the surface of the soil and reduce yields of crops, and that it should not be used as a fence round either crops or pasture. According to Pobeguin (1) the roots contain a more or less toxic substance and it may be that it is this substance that inhibits plant growth.

**B. Azadirachta indica** (Neem) A. Juss.

In May, 1944 not long after the first light rains along the far edge of a similar ditch a number of young shoots of Neem appeared. The plot bordered by this ditch was planted with an introduced variety of *Pennisetum* Sp.? in 1943 and a number of large semi-circular patches of poor growth radiating outwards from the ditch had been very noticeable during the rains and some of these patches were still noticeable in May, 1944 before the *Pennisetum* had produced any new growth. The live fence in this case is 200 feet long and consists of a mixture of plants including 11 young Neem trees in four groups spaced at interval.

The ditch is 2 feet wide and 6 feet from the live fence, and the total number of shoots of Neem counted on the side of the ditch furthest from the fence was 19. The cut ends of roots from which two of these shoots arose were dissected and followed until they turned vertically downwards. The roots lay between 6 and 12 inches below the surface deeper than *Newbouldia laevis*, and the furthest distance from the Neem tree in the live fence that a root was traced was 28 feet, while the greatest length of roots was 29 feet from the shoot *i.e.*, at least 37 feet measured from the parent tree.

(1) Useful Plants of West Tropical Africa. J. M. Dalziel, p. 444.

This particular live fence is made up as follows:—

11 *Azadirachta indica* A. Juss. (Neem)
20 *Newbouldia laevis* Seem.
12 *Glyricidia maculata* H.B.K.
7 *Commiphora pedunculata* Engl.
6 *Boswellia Dalzielii* Hutch.
6 *Commiphora Kerstingii* Engl.
5 *C. Africana* Engl.
3 *Moringa pterigospermum* Gaertn.
2 *Jatropha Curcas* Linn.

No shoots of *Newbouldia laevis* have so far appeared at the edge of the ditch, so that cut off roots of these plants have probably all died. The patches of bad growth are opposite the groups of Neems and this was particularly noticeable where the roots were actually dissected, and it is therefore concluded that the roots of Neem (*Azadirachta indica*) inhibit the growth of certain grasses and crop plants. The other plants included in this particular live fence have not so far been suspected of exerting a deleterious effect on crops grown near them.

### Conclusion

Neither *Newbouldia laevis* Seem nor *Azadirachta indica* (Neem) should be planted round farms or paddocks as their roots grow from a few inches to a foot below the surface of the soil and spread over a large area causing patchiness in crops and grasses.

### Acknowledgment

Much of this information about hedge plants has been supplied by various Agricultural Officers in their reports. My African staff, particularly Mr. A. Oji, Agricultural Assistant, were responsible for the dissection of the root systems of *Newbouldia laevis* and *Azadirachta indica*.

## ORGANIC PHOSPHORUS IN SOILS *

BY

A. G. POLLARD

For a number of years the behaviour of phosphorus compounds in soil, more especially in relation to plant nutrition and to the action and availability of fertilizers, has presented a complex problem to the soil chemist. The search for a fundamental chemical explanation of the activity, or frequently of the apparent inactivity, of phosphorus-containing materials in soil and thence for a basic method of assessing the value of soil-phosphorus for crop production has not yet brought more than partial success. Theories based on reactions of inorganic compounds or of adsorption complexes have proved inadequate even if the existence of a multiplicity of hitherto unknown inorganic phosphates was postulated.

Organic compounds of phosphorus, known to occur in plant and animal residues, must obviously exist at least temporarily in soil, but have been regarded as being substantially unavailable to plants until slowly decomposed to yield inorganic phosphates. Moreover, the essential nature of phosphorus in the development of micro-organisms indicates the probable formation of organic compounds as products of metabolism of soil bacteria. Among recent investigations on this aspect of the question may be quoted that of S. C. Chang (1) who demonstrates that the micro-biological decomposition of organic matter by soil micro-organisms is accompanied by the conversion of inorganic into organic compounds

* From *Ann. Repts. Soc. Chem. Indus. Prog. App. Chem.* Vol. XXVI, p. 366.

of phosphorus to extents which are largely controlled by the supply of available phosphate and of energy material to the micro-organisms. The gradual exhaustion of energy sources is followed by the utilisation of previously formed organic phosphorus compounds as an energy supply with consequent liberation of phosphorus as inorganic phosphate. These observations accord with the known effect (further elaborated by Chang) of soluble phosphates in facilitating the decomposition of cellulose in soil. The somewhat indefinite reserve of organically combined phosphorus in soil has received only secondary consideration in the more immediate problems of crop nutrition.

In recent years the development of analytical methods for differentiating with greater certainty between organic and inorganic forms of phosphorus (2) in soil has facilitated and stimulated further investigation of the rôle of organic phosphorus in plant nutrition (3). Current research includes at least three important lines of approach to the general problem, viz., (*a*) the isolation of individual phosphorus-containing organic compounds or types of compounds from soil and an examination of their production or decomposition by micro-organisms or enzymes; (*b*) examination of the proportions of organic and inorganic phosphorus in soils under various manurial or cropping conditions; (*c*) the direct investigation of the nutrient value of organic phosphorus compounds for plants.

C. L. Wrenshall and W. J. Dyer (4), developing their earlier investigations, have further improved methods for extracting phosphorus compounds from soil (5), and now record (6) that hot 5 per cent. aqueous ammonia may extract upwards of 90 per cent. of the total organic phosphorus from acid-washed soils. Of this, approximately 40 per cent. is precipitable with the humus and 35-46 per cent. is accounted for as "nucleotides". The presence of phytin in the extracts is also demonstrated (7) and its probable occurrence in soil as ferric phytate is indicated (8). R. K. Yoshida (9) records the isolation from soil of a substance closely resembling a phosphate of inositol, but the failure to detect nucleic acid compounds.

In another paper Dyer and Wrenshall (10) examine the stability of various organic phosphorus compounds in soil. In general, the proportion of organic phosphorus is higher in acid in neutral or alkaline soils, and it is to be assumed on this basis that neutral conditions favour the decomposition of these compounds by soil bacteria. It was found that the production of inorganic phosphate from nucleic acid occurred at varying rates in different soils. Phytin was decomposed only slowly at rates approximating to that of the decomposition of animal manure. It is concluded that the principal phosphorus compounds likely to accumulate in soils are nucleotides, phytin, and possibly inositol phosphates. Phytin complexes formed with iron and with aluminium are insoluble and not subject to enzymic decomposition.

In field soils the proportion of organic phosphorus is highest in the surface layer (11). Factors affecting changes in the organic-inorganic balance of phosphorus in soils are examined by W. A. De Long, A. J. Sutherland and P. L. Archer (12). Of the readily extractable phosphorus the organic fraction appears to increase as summer conditions (higher temperature, lower water content) approach, probably as a result of accelerated microbiological activity. The reverse process (relative increase in the inorganic fraction) occurred in soil samples treated with chloroform, and is explained by the decomposition of organic phosphorus constituents of dead micro-organisms by surviving enzymes. Approaching the problem from a different angle, L. A. Pinck, M. S. Sherman, and F. E. Allison (13) show that in certain soils the fixation of phosphorus added in soluble forms, e.g., glycerophosphate, hexose phosphate, sodium nucleate, dipotassium phenyl phosphate, disodium ethyl phosphate, was sufficiently rapid to indicate adsorption by soil colloids. In other soils fixation was less rapid and suggestive of decomposition by soil organisms and subsequent reversion to insoluble inorganic phosphates. By contrast non-ionised (triethyl, trimethyl) phosphates remained unchanged in soil for several weeks. J. P. Conrad (14) records somewhat similar observations. It would seem therefore that fixation of phosphorus in soil is not necessarily limited to reactions between mineral phosphates, and moreover that the penetration of manurial phosphates into soil may perhaps take place through the agency of soluble organic phosphorus compounds.

(1) *Soil Sci.*, 1940, 49, 197; B., 1940, 816.
(2) R. W. Pearson, *Ind. Eng. Chem.* (*Anal.*), 1940, 12, 198; B., 1940, 475.
(3) *Ann. Repts.* 1939, 24, 480.
(4) *Soil Sci.*, 1941, 51, 159, 235, 323; B., 1941, III, 317.
(5) C. L. Wrenshall and W. J. Dyer, *Canad. J. Res.*, 1939, 17, B., 199; B., 1940, 632.
(6) W. J. Dyer and C. L. Wrenshall, *Soil Sci.*, 1941, 51, 159; B., 1941, III, 317.
(7) W. J. Dyer, C. L. Wrenshall and G. R. Smith, *Science*, 1940, 91, 319; A., 1940, III, 548.
(8) C. L. Wrenshall and W. J. Dyer, *Soil Sci.*, 1941, 51, 235; B., 1941, III, 317.
(9) *Ibid*, 1940, 50, 81; B., 1941, III, 34.
(10) C. L. Wrenshall and W. J. Dyer, *Soil Sci.*, 1941, 51, 323; B., 1941, III, 317.
(11) *Proc. Soil. Sci. Soc. Amer.* (1939), 1940, 4, 162; B., 1941, III, 115.
(12) *Sci. Agric.*, 1940, 21, 92; B., 1942, III, 43.
(13) *Soil Sci.*, 1941, 51, 351; B., 1941, III, 317.
(14) *J. Agric. Res.*, 1939, 59, 507; B., 1940, 475.

## RESPONSE OF TEA TO NITROGEN

According to the *Annual Report of the Tea Research Institute* (1942), it has been confirmed that tea shows directly proportional responses to increasing applications of nitrogen, even up to 80 lb. of nitrogen per acre; and that manure applied at the time of pruning is relatively ineffective as compared with applications made a few months later.

# CHEMICAL NOTES

*(Compiled by the College Department of Chemistry and Soil Science)*

## Soil Structure

In an article by W. S. Martin which appeared in the *E. Afric. Agric. J.* 9, 1944, the terms texture, structure and tilth are re-defined. Texture is permanent (except for changes brought about by sheet erosion) and is based on size-distribution of the ultimate soil particles as revealed by mechanical analysis. Structure indicates the aggregation of the ultimate particles into crumbs (water-stable compound particles); it can be modified by cultural operations. Tilth is a practical agricultural term referring usually to the state of the seed-bed; whilst tilth is a function of both texture and structure, it is most profoundly influenced by the timing of cultural operations. The distinction between texture and structure is demonstrated by three glass jars: one containing soil of good structure in field state, another with the same soil passed through a 3-mm. sieve, another with sieved soil broken down by grinding with a wooden pestle in a wooden mortar. These specimens—obviously of the same texture—have different structures and consequently different permeabilities and porosities.

In the period 1924-1933 the major field experiments in Uganda had proved that arable rotations and legumes had not maintained soil fertility; hence in 1934 the focus of field experimental work was changed from the manurial to the soil-structural. It has been shown that organic manures (farmyard manure, cotton-seed or green manure) do not have any significant effect on soil structure. A ten-year experiment at Serere has shown that lime with or without green manure has no significant effect on structure or yield. Organic manures still have a place as crop feeders—often giving increases in yield—so that it is good if they can be used within a grass rotation. All the field observations in Uganda suggested that it was the physical rather than the chemical condition of the soil that determined fertility. Physical fertility has been maintained by adopting a rotation including grass (elephant grass) and cotton.

The rotation adopted (approximately three years under grass—which may be lightly grazed—and three years under crop) is "only the native shifting cultivation accelerated and remodelled." Natural regeneration of grass seems likely to be better than sowing any artificial mixture. Over-cultivation must be avoided from the standpoints of both structure and yield: rough preparation of land is encouraged for big-seeded crops such as cotton. There is a close relation between the percentage of moisture at the sticky-point and the crumb-forming capacity of the soil; while no amount of "resting" under grass could be expected to produce crumbs in soils of sticky-point 16, with rising sticky-point values the percentage of water-stable crumbs rises. Like wet sieving, the sticky point is a simple determination (it is performed by an African staff) and it seems possible that these methods will give the actual and potential crumb percentages respectively. The growth of 33 species and strains of local grasses established in field plots at Kampala produced wet-sieving percentages (Tiulin) of crumbs over 0.5 mm. of from 47.6 (*Setaria sphacelanta*) and 41-46 (*Brachiaria* spp.) down to 23 (*Paspalumauriculatum*). Only six gave percentages above 40, and 20 species gave a percentage of 32 or less. Various soils under grass having wet-sieving percentages up to 60 had the value reduced to 30 by cultivation. Root-distribution and the influence of effective and ineffective species of grass upon structure of field soil in depth are illustrated.—(*Soils and Fertilizers*, Vol. VII, No. 3, 1944).

* * *

## Nitrogen Fertilizers and Sugar Cane

In Hawaii after ten years' usage and comparison of excessively heavy applications of nitrogen fertilizers (ammonium sulphate, nitrate of soda, urea) on an originally acid soil, no significant differences in sugar yields have been found in spite of the great changes which the treatments have made in the soil pH.—(*Soils and Fertilizers*, VII, No. 3, 1944. See also *Printed Reports of 63rd Annual Meeting*, (1942) *Hawaiian Sugar Planters' Association*).

**VACANCY FOR SENIOR FIELD ASSISTANT**
AT
**THE SUGAR RESEARCH OFFICE**
OF
**THE SUGAR MANUFACTURERS' ASSCN. (JAMAICA) LTD.**

The Sugar Research Department of the Sugar Manufacturers' Association (of Jamaica) Ltd., require the services of a Senior Field Assistant for Sugar Cane experimental work.

The candidate should have a degree or diploma in Agriculture from a recognised University or College. Expérience in Tropical Agriculture and knowledge of agricultural statistics will be an advantage.

Salary scale £650-25-750 per annum, with travelling and subsistence allowances. Free passages provided. It is intended to introduce a contributory provident fund scheme.

Appointment will be made initially on an agreement for three years subject to a specified period of notice on either side.

In view of the development of Sugar Research in Jamaica, prospects of advancement are good.

Applications with references and copies of testimonials should be sent, by February 28, 1945, to:—

The Sugar Research Officer,
Sugar Research Office,
162, Hope Road,
Liguanea P. O.,
Jamaica, B.W.I.